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ABSTRACT

Three tables are provided to aid in the clinical interpretation of factor scores for the Wechsler Adult Intelligence Scale-Revised (WAIS-R; 1981). The factor structure of the WAIS-R has proven to be robust across samples, tests, time, statistical analyses, measurement scales, and distortions of the distribution. Information necessary to make practical use of these findings includes: reliability coefficients; difference scores required for statistical significance; standard errors of estimation and prediction; and data on the abnormality of differences between scores. Operations necessary for clinical use include: (1) calculation of predicted true scores; (2) calculation of standard errors of estimation and prediction; (3) calculation of significant differences; and (4) calculation of abnormality of differences. The use of the tables is illustrated via an analysis of the scores on the WAIS-R of a 65-year-old client. (SLD)

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Reliability, Errors, Significance, and Abnormality: WAIS-R Factor Scores

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Abstract

Tables are provided to aid in the clinical interpretation of WAIS-R factor scores.

Introduction

The factor structure of the Wechsler Adult Intelligence Scale - Revised (Wechsler, 1981) has proven robust across samples, tests, time, statistical analyses, measurement scales, and distortions of the distribution (Atkinson et al., in press). If we are to make practical use of these findings in interpreting examinees' factor scores, then we need information comparable to that provided for interpretation of WAIS-R Full Scale, Verbal, and Performance IQs. Necessary information includes reliability coefficients, difference scores required for statistical significance, standard errors of estimation and prediction, and data on the abnormality of differences between scores.

This paper supplies the requisite tables for factor score interpretation.

Method and Results

Construction of Factors

Each of the three WAIS-R factors, Verbal Comprehension (VC), Perceptual Organization (PO), and Memory/Freedom from Distractibility (M/FD) -- were represented as follows:

Verbal Comprehension

Vocabulary

Information

Comprehension

Perceptual Organization

Block Design

Object Assembly

Memory/Freedom from Distractibility

Digit Span

Arithmetic

Calculation of Predicted True Scores

The calculation of "predicted true scores" is necessary for clinical use of the tables. The best prediction of an examinee's "true" score is not the one s/he actually obtains on administration of the test, but a score based on the obtained score and regressed toward the mean.

The procedure for computing a predicted true factor score is as follows. (a) Sum the age appropriate scaled scores obtained on the subtests which comprise the factor of interest (X_o). (b) convert X_o to a Deviation Quotient (DQ) with a mean of 100 and a standard deviation of 15: $DQ = 15/SD_o(X_o - M_o) + 100$, where SD_o = standard deviation of the observed distribution (calculated with

Tellegen and Briggs' (1967) formula, and provided in Table 1 of the present article), and M_o = mean of the obtained distribution (i.e., 30 for VC, 20 for PO and M/FD). (c) To convert the DQ to a predicted true DQ (DQ_{PT}), (i) multiply DQ x $\underline{r}_{cc}$, where $\underline{r}_{cc}$ = reliability of the factor composite ($\underline{r}_{cc}$s, calculated with Tellegen and Briggs' formula, are provided in Table 1), (ii) multiply 100 x (1 - $\underline{r}_{cc}$), and (iii) add i and ii = DQ_{PT}.

Calculation of Standard Errors of Estimation and Prediction

Standard errors of measurement can take three forms. The two standard errors of measurement which are of interest here are the standard errors of estimation (SE_E) and prediction (SE_p). The SE_E is used to bracket an individual's predicted true score such that we can ascertain with a predetermined degree of confidence the range within which his/her "true" score actually lies. The formula for computing the SE_Es of subtest composites, such as represent VC, PO, and M/FD, $\underline{\sigma}_{\sim 1} = \underline{\sigma}_1[\underline{r}_{cc}(1 - \underline{r}_{cc})]^{.5}$, where $\underline{\sigma}_{\sim 1} = SE_E$, $\underline{\sigma}_1$ = the standard deviation of the obtained test scores (in the case of the DQs discussed above, 15), and $\underline{r}_{cc}$ is as defined above). SE_Es were determined for each WAIS-R factor across all age groups and are offered on Table 1.

The SE_p is used to establish a confidence interval for a score on the second administration of a test. SE_p is used if one wants to determine if the observed change in score from first administration to second administration is due to measurement error or can be attributed to some extraneous cause (e.g., intervening treatment, organicity). The formula for calculating SE_ps for the factors is $\underline{\sigma}_{11} = \underline{\sigma}_1(1 - \underline{r}_{cc}^2)^{.5}$, where $\underline{\sigma}_1$ and $\underline{r}_{cc}$ are as

defined above. SE_ps for all factors and age groups are provided on Table 1.

Calculation of Significant Differences

Differences between VC, PO, and M/FD DQs required for significance were calculated with a minor revision of the usual formula (Anastasi, 1988; Sattler, 1988), $z\sqrt{SE_{E1}^2 + SE_{E2}^2}$, where z = normal curve value representing the desired confidence level. The results are displayed on Table 2.

Calculation of Abnormality of Differences

Having established that a difference between two factor scores is statistically significant, it may be of diagnostic relevance to determine how frequently such a discrepancy occurs in the general population, or, operationally, in the standardization sample. I followed Payne and Jones' (1957) procedure for calculating this statistic. The requisite correlations between factor composites were computed with Ghiselli, Campbell, and Zedeck's (1981) formula 7-18. Results are displayed on Table 3.

Discussion

To illustrate use of the Tables, let us take the example of a 65 year old client whose age scaled scores (Wechsler, 1981, Table 21) on components of the VC factor are 13 (Information), 14 (Vocabulary), and 14 (Comprehension). Following the instructions provided above: (a) scores are summed -- $X_o = 41$, (b) converted to a DQ -- $15/SD_o(X_o - M_o) + 100 = 15/8.4(41 - 30) + 100 = 120$ (SD_o is given in Table 1, second column), c) converted to a DQ_{pT} -- (i) DQ x $\underline{r}_{cc} = 120 \times .97 = 116$ ($\underline{r}_{cc}$ is given in Table 1, third column), (ii) $100(1 - \underline{r}_{cc}) = 3$, (iii) i + ii = 119 = DQ_{pT}. With familiarity, these calculations take less than a minute.

To set 68%, 85%, 90%, 95%, or 99% confidence intervals, multiply the appropriate standard error (given in Table 1, columns 4 and 5) by 1.00, 1.44, 1.64, 1.96, or 2.58, respectively. Thus, we can say with 95% confidence that this individual's true VC DQ is 119 $\pm$ 1.96 SE_E, or 119 $\pm$ 5. Furthermore, we can predict with the same degree of confidence that on retesting his/her DQ will fall within the interval 119 $\pm$ 1.96 SE_p, or 119 $\pm$ 7. Should a second administration VC DQ fall beyond this zone, it is probable that some extraneous influence has intervened.

Let us suppose that on first assessment this hypothetical individual also earned a M/FD DQ_{pT} of 105. Reference to Table 2 shows that the 14 point discrepancy in the 65 - 69 year age range is significant at the .01 level.

Finally, entering Table 3 and finding the discrepancy which is closest to the 15 point VC - M/FD DQ difference (here we are

using DQs, rather than DQ_{PT}s) obtained by this client, we find that more than 25% of 65 - 69 year-olds in the normative sample earned a discrepancy this great or greater. Thus, Tables 1, 2, and 3 can be used to determine the reliability of VC, PO, and M/FD DQs, and the significance of their discrepancies and fluctuations, in a manner analogous to more traditional profile interpretation using Verbal, Performance, and Full Scale IQs.

Table 1

Standard Deviations (SD), Reliability Coefficients (r_{cc}), and Standard Errors of Estimation (SE_E) and Prediction (SE_P) for WAIS-R Factor Scores

	VC				PO				M/FD			
Age	SD	r_{cc}	SE_E	SE_P	SD	r_{cc}	SE_E	SE_P	SD	r_{cc}	SE_E	SE_P
16-17	8.14	.95	3.24	4.64	5.32	.81	5.93	8.88	5.26	.82	5.82	8.69
18-19	8.15	.95	3.18	4.55	5.28	.87	5.13	7.53	5.16	.83	5.58	8.28
20-24	8.09	.95	3.39	4.86	5.37	.87	5.01	7.34	5.26	.91	4.31	6.25
25-34	8.22	.96	2.94	4.20	5.47	.87	5.05	7.40	5.28	.92	4.09	5.91
35-44	8.16	.96	2.90	4.15	5.55	.89	4.71	6.87	5.35	.91	4.25	6.15
45-54	8.22	.96	2.97	4.25	5.50	.87	5.11	7.50	5.30	.89	4.68	6.81
55-64	8.23	.96	2.90	4.15	5.38	.86	5.25	7.73	5.30	.90	4.48	6.51
65-69	8.35	.97	2.60	3.71	5.48	.86	5.17	7.60	5.35	.90	4.44	6.45
70-74	8.13	.96	3.11	4.45	5.40	.83	5.60	8.30	5.37	.90	4.50	6.54

Note: WAIS-R = Wechsler Adult Intelligence Scale - Revised; VC = Verbal Comprehension; PO = Perceptual Organization; M/FD = Memory/Freedom from Distractibility.

Table 2

Differences Between WAIS-R VC, PO, and M/FD DQs Required for Significance

	Confidence Level (%)											
	VC-PO				VC-M/FD				PO-M/FD			
Age	85	90	95	99	85	90	95	99	85	90	95	99
16-17	10	11	13	17	10	11	13	17	12	14	16	21
18-19	9	10	12	16	9	11	13	17	11	12	15	20
20-24	9	10	12	16	8	9	11	14	10	11	13	17
25-34	8	10	11	15	7	8	10	13	9	11	13	17
35-44	8	9	11	14	7	8	10	13	9	10	12	16
45-54	9	10	12	15	8	9	11	14	10	11	14	18
55-64	9	10	12	15	8	9	10	14	10	11	14	18
65-69	8	10	11	15	7	8	10	13	10	11	13	18
70-74	9	11	13	17	8	9	11	14	10	12	14	19

Note: WAIS-R = Wechsler Adult Intelligence Scale - Revised; VC = Verbal Comprehension; PO = Perceptual Organizatien; M/FD = Memory/Freedom from Distractibility; DQ = Deviation Quotient.

Table 3

Abnormality of Differences Between WAIS-R Factor Scores

Scale	(%)[1]	Age in Years								
		16-17	18-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74
Verbal Comprehension - Perceptual Organization										
	25	16.7	17.5	17.0	15.5	15.2	16.2	16.8	16.2	17.0
	10	23.8	25.0	24.4	22.2	21.7	23.2	24.0	23.1	24.3
	5	28.4	29.8	29.1	26.4	25.9	27.6	28.6	27.6	29.0
	1	37.3	39.1	38.2	34.7	34.0	36.3	37.6	36.2	38.1
Verbal Comprehension - Memory / Freedom from Distractibility										
	25	14.5	14.4	15.6	13.2	12.6	14.0	14.2	13.7	13.7
	10	20.7	20.6	22.4	18.8	18.1	20.0	20.2	19.6	19.5
	5	24.7	24.6	26.6	22.4	21.5	23.8	24.1	23.3	23.3
	1	32.5	32.3	35.0	29.5	28.3	31.3	31.7	30.7	30.6

Table 3 Continued

Scale	(%)[1]	Age in Years								
		16-17	18-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74
Perceptual Organization - Memory / Freedom from Distractibility										
	25	17.4	17.4	17.4	16.3	14.9	16.2	14.8	16.4	17.4
	10	25.0	24.9	24.9	23.3	21.3	23.2	21.1	23.5	24.9
	5	29.7	29.6	29.7	27.7	25.4	27.6	25.2	28.0	29.6
	1	39.1	38.9	39.0	36.4	33.4	36.3	33.1	36.8	38.9

Note: WAIS-R = Wechsler Adult Intelligence Scale - Revised; VC = Verbal Comprehension; PO = Perceptual Organization; M/FD = Memory/Freedom from Distractibility; DQ = Deviation Quotient.

[1] Percent of standardization sample obtaining a given or greater discrepancy.